SAE International G-11 Standards Development in System Reliability

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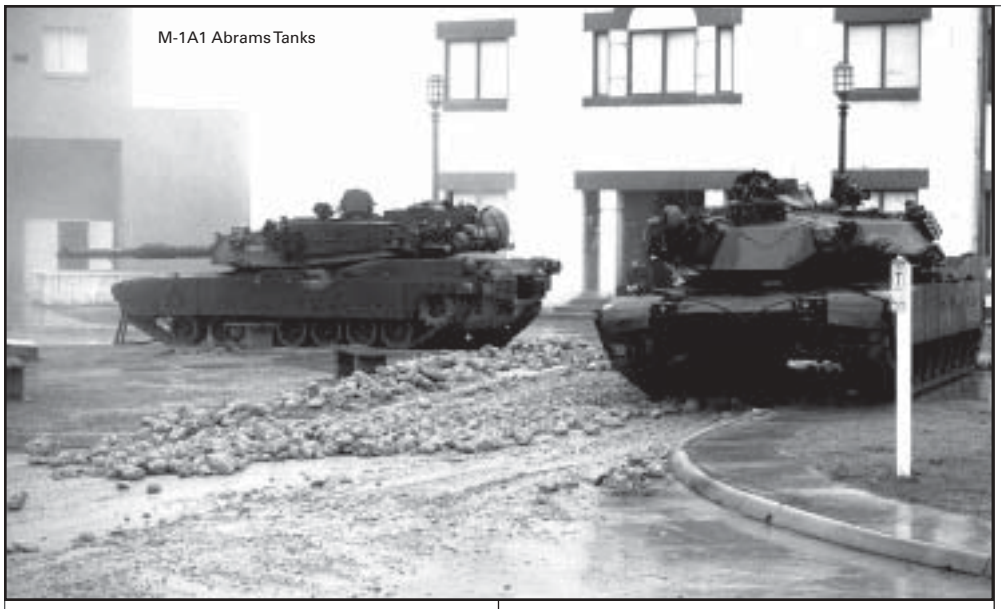
BEST BUSINESS PRACTICES

SAE International's G-11 Standards Division on Reliability, Maintainability, Serviceability and Logistics (RMSL) held its semiannual workshop Oct. 6-8, 2003, in Detroit, MI. The G-11 Division mission for RMSL provides an industry/government forum to review RMSL technology and investigates the interfaces with logistics support, engineering design and development, support costs, maintainability, reliability, repairability, tooling and diagnostics. This particular SAE Division's importance to the Army was emphasized by the attendance of GEN Paul J. Kern, Commanding General (CG), Army Materiel Command; MG N. Ross Thompson, CG, U.S. Army Tank-automotive and Armaments Command; and BG William M. Lenaers, CG, U.S. Army Ordnance (OD) Command and School, with full realizations that their presence was required at the opening ceremonies for the Association of the United States Army (AUSA) Annual Convention in Washington, DC, that afternoon.

About 22 years ago, SAE began a committee to address the reliability of aerospace systems, primarily focused on developing standards in RMSL. Since then, the G-11 Committee was expanded to the G-11 Division and has published 24 standards, guidelines and documents (based on statistical methods), which have been used by various international organizations. They have also been accepted by NATO and the United Kingdom's Ministry of Defence, and have been cited by the Canadian Defence organization. The Division's current emphasis is on probabilistic methods for reliability computation to build consensus for "uncertainty-based physical modeling," a much more accurate way of predicting reliability. In 1992, the G-11 Committee expanded its focus to include the automotive industry and received the "JA" designation signifying the standards for both aerospace and automotive applications. In March 2003, Dr. David Gorsich, U.S. Army, National Automotive Center (NAC), and Professor K.K. Choi, University of Iowa, formed a new committee to analyze the uncertainties in system designs for military vehicles. Army vehicles include tanks, trucks, personnel carriers, High-Mobility Multipurpose Wheeled Vehicles (HMMWVs), helicopters and planes.

GEN Paul J. Kern, CG, Army Materiel Command, stressed the need for the Army to improve the reliability of systems to sustain warfighters during a G-11 Standards Workshop in Detroit, MI, last October.

The 3-day workshop included informational briefings on Soldiers' in-theater needs. GEN Kern stressed the need for the Army to improve the reliability of Army systems to sustain warfighters. He stated that analyzing uncertainties within mission scenarios will ensure the objective is obtained and reduce the element of risk to our Nation's Soldiers. Kern also stressed that the Army's reliability record needs improvement and complimented the U.S. Army Tank Automotive Research, Development and Engineering Center's (TARDEC's) NAC for working to establish G-11's Reliability Applications Committee to develop standards and methodologies for evaluating the reliability and durability of current and future Army systems. Kern stressed that using historic deterministic modeling methods to evaluate systems is important, but future work should concentrate on stochastic and probabilistic methods as well.

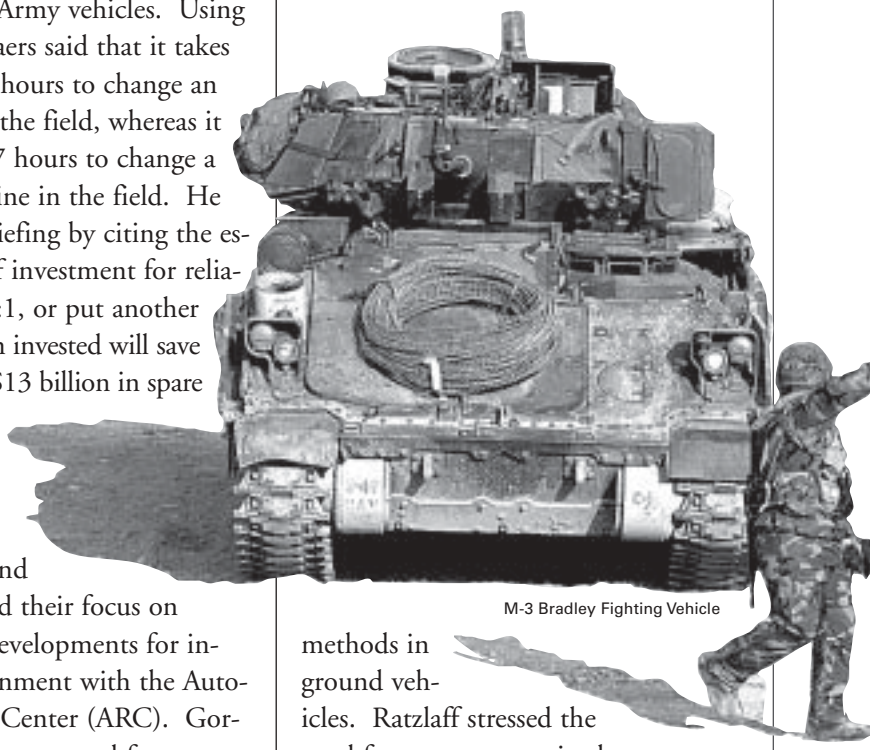

M-1A1 Abrams Tanks

MG Thompson addressed TARDEC's modeling and simulation (M&S) capabilities by citing its developing ability to consistently predict and design reliability, durability and sustainability into Army systems. Thompson stressed that current Army system reliability is not acceptable and that sustainability requires reliable and maintainable components. He further stated that from 1985 to 1995, 41 percent of Army systems met the reliability requirement. This percentage decreased dramatically to only 20 percent of Army systems between 1996 and 2000 and the trend appears to be downward. Thompson remarked that Army system RMSL requirements must be addressed during initial design stages. Further, to improve reliability, he said engineers should consider using reliability-based design optimization and/or robust design optimization methods. Thompson concluded by saying, "Standardization of M&S methodologies through SAE's G-11 is crucial to reducing the Army's operational and supportability costs and meeting the Future Force requirements."

BG Lenaers further emphasized the Army's need to improve current and future systems. The combination of Quartermaster and OD — which is the bulk of the Army's personnel logistic footprint — is larger than the sum of all the combat arms branches combined. He stated that 90 percent of the 117,000 soldiers he commands work directly with the maintenance of Army vehicles. Lenaers stated that reliability affects 58 percent of life-cycle costs, including system maintainability. He explained why engineers must build reliability and maintainability requirements into Army vehicles. Using an example, Lenaers said that it takes about 1.5 to 2.0 hours to change an M113 engine in the field, whereas it requires about 37 hours to change a HMMWV's engine in the field. He concluded his briefing by citing the estimated return of investment for reliability equals 130:1, or put another way, $100 million invested will save the Army about $13 billion in spare parts over a 7-year period.

Dennis Wend, NAC Director, and Gorsich presented their focus on dual-use M&S developments for industry and government with the Automotive Research Center (ARC). Gorsich stated that current and future ARC projects include researching and developing probabilistic and stochastic modeling methodologies, safety modeling: the human-centered modeling and simulation, linking physics models to acquisition decisions and databases that work with maintenance decisions/purchases and enhancing performance with embedded models and metamodels. ARC research projects are quad-concept based — teams are comprised of industry and government participants as well as one faculty principal and one student/graduate researcher to investigate and research areas of interest to both government and industry. The quad concept ensures that dual-use technology is developed. Gorsich concluded by discussing TARDEC M&S team's current capabilities and his future vision for developing and applying probabilistic and stochastic methods to improve the reliability of Army systems.

The final keynote address was given by Barry Ratzlaff from DaimlerChrysler. He presented the industry perspective on using reliability and probabilistic methods in ground vehicles. Ratzlaff stressed the need for more experts in these areas to research probabilistic methods to develop templates so that the probabilistic methodologies and tools could


M-3 Bradley Fighting Vehicle

become useable by nonexpert probabilistic method engineers. He noted that the industry must develop new models, refine the models not yet ready for production and train new engineers to better understand the meaning and implication of variation.

The G-11 Ground Vehicle Division is looking for technical volunteers to address key areas affecting RMSL for the Army and industry. A key area of focus is statistical and physics-based probabilistic methods used to quantify the reliability of complex systems. Currently, work is underway to evaluate probabilistic technologies and to develop guidelines for preparing inputs for probabilistic analyses. Other activities include investigating real-world applications for probabilistic methods, using probabilistic methods in diagnostic capabilities and determining the need for universities to offer courses in probabilistic methods.

Integration between hardware and software, as well as environmental factors, affect the overall system reliability.

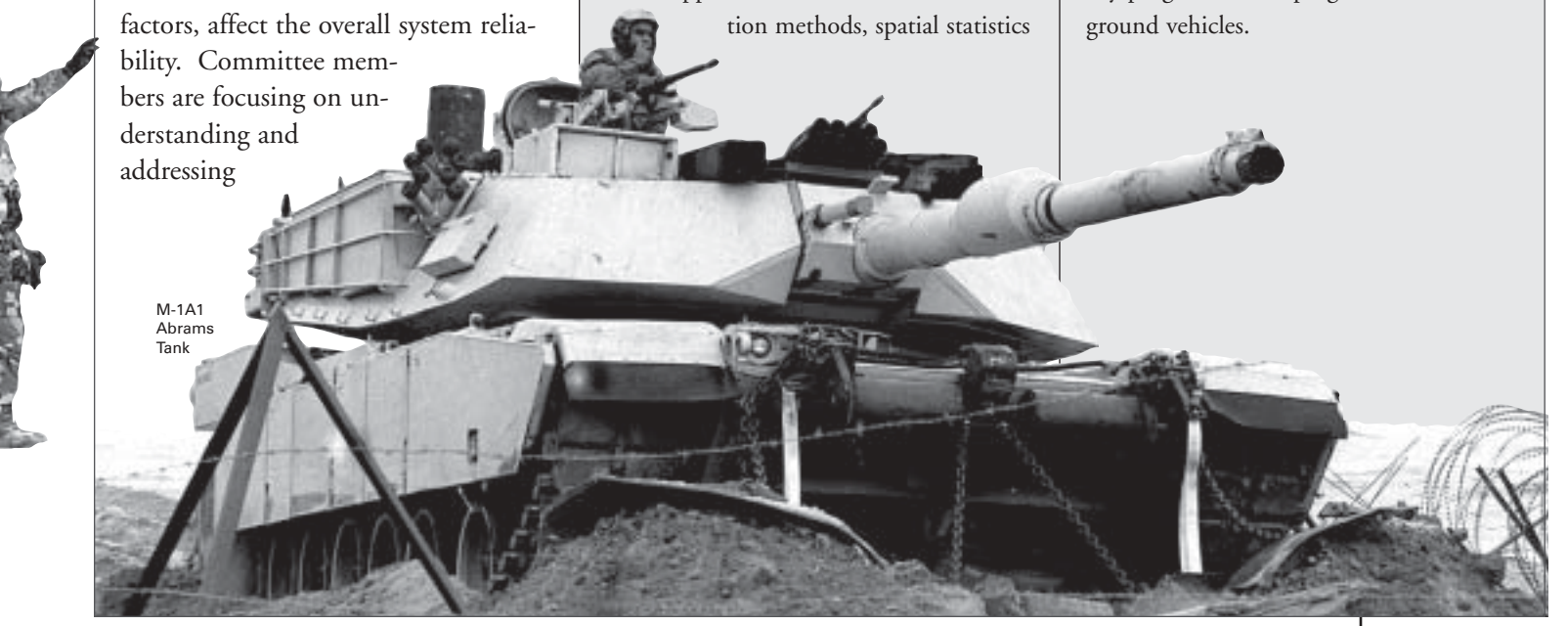
Reliability is a key performance parameter when developing complex systems. Integration between hardware and software, as well as environmental factors, affect the overall system reliability. Committee members are focusing on understanding and addressing the current definition of reliability — including system-of-systems, software and their interactions — to determine how their relationship affects system reliability in general. Their goal is to develop solutions and guidelines to maximize the reliability of a system and standardize the definitions. Currently, the Reliability Committee is working on case studies, defining and clarifying terminology, data requirements/availability and validation/verifications in integrated testing and simulations. To learn more about the G-11 Committee on Reliability, contact Gorsich at **gorsichd@tacom.army. mil**, Dr. Greg Hudas at **hudasg@ tacom.army.mil** or Kuper at **robert.kuper@us.army.mil**.

DR. DAVID GORSICH is the Associate Director for M&S at TARDEC. He earned his B.S. in electrical engineering from Lawrence Technological University, his M.S. in applied mathematics from The George Washington University and his Ph.D. in applied mathematics from M.I.T. As a research scientist, his interests are in approximation, numerical simulation methods, spatial statistics and learning theory. He has more than 80 conference and journal publications in these areas.

BOB KUPER is the Executive for Reliability and manages the Army Transformation Improvement Program at the U.S. Army Armaments Research, Development and Engineering Center. He serves as Vice Chairman of the Society of Automotive Engineers G-11 Division and also chairs the Reliability Committee. Kuper received his B.S. degree from the U.S. Military Academy and has completed graduate work at Steven's Institute of Technology and the New Jersey Institute of Technology. In addition, he graduated from the Defense Systems Management College's Advanced Program Management Course and is Level III certified in program management and systems planning, research, development and engineering.

HEATHER MOLITORIS is a TARDEC Mechanical Engineer. She received her B.S.E. in mechanical engineering at Oakland University in 2003. She is currently working SAE International Standards development for NAC involving M&S technology.

TOM UDVARE is a TARDEC Electrical Engineer. He received his B.S. in electrical engineering at Lawrence Technological University. He works with various university programs developing M&S tools for ground vehicles.



M-1A1 Abrams Tank